Docket: 2060/1 C1

Claims:

1. An optical switch comprising:

a plurality of input/output ports for receiving one or more wavelength component(s) of an optical signal; and

an optical arrangement directing said wavelength component to any given one of the plurality of input/output ports, said given input/output port being variably selectable from among any of the plurality of input/output ports.

2. The optical switch of claim 1 wherein said optical signal is a broadband signal and said optical arrangement is wavelength-independent.

3. The optical switch of claim 1 wherein said optical arrangement retroreflects said wavelength component.

4. The optical switch of claim 2 wherein said optical arrangement retroreflects said broadband signal.

5. The optical switch of claim 1 wherein said optical signal includes a plurality of wavelength components and said optical arrangement comprises:

at least one wavelength selective element selecting one of said wavelength components from among the plurality of wavelength components; and

a plurality of optical elements each associated with one of the wavelength selective elements, each of said optical elements directing the selected wavelength component selected by the associated selective element to a given one of the plurality of input/output ports independently of every other wavelength component, said given input/output port being variably selectable from among any of the plurality of input/output ports.

6. The optical switch of claim 1 further comprising a free space region disposed between the input/output ports and the optical arrangement.

7. The optical switch of claim 5 further comprising a free space region disposed between the input/output ports and the wavelength selective elements.

8. The optical switch of claim 5 wherein said wavelength selective elements are thin film filters each transmitting therethrough a different one of the wavelength components and reflecting the remaining wavelength components.

9. The optical switch of claim 8 wherein said wavelength selective elements are bulk diffraction gratings.

10. The optical switch of claim 5 wherein said optical elements are reflective mirrors that are selectively tiltable in a plurality of positions such that in each of the positions the mirrors reflect the wavelength component incident thereon to any selected one of the input/output ports.

11. The optical switch of claim 10 wherein said reflective mirrors are part of a micro-electromechanical (MEM) retroreflective mirror assembly.

12. The optical switch of claim 11 wherein said retroreflective mirror assembly includes an aspheric lens.

13. The optical switch of claim 12 wherein said retroreflective mirror assembly includes a curved reflector element.

14. The optical switch of claim 10 wherein said reflective mirrors are part of a retroreflective optical assembly.

15. The optical switch of claim 10 wherein said reflective mirrors each include a piezoelectric actuator.

16. The optical switch of claim 7 wherein said free space region comprises an optically transparent substrate having first and second parallel surfaces, said plurality of wavelength selective elements being arranged in first and second arrays extending along the first and second parallel surfaces, respectively.

17. The optical switch of claim 15 wherein the optically transparent substrate includes air as a medium in which the optical signal propagates.

18. The optical switch of claim 16 where the optically transparent substrate is silica glass.

19. The optical switch of claim 16 wherein said first and second arrays are laterally offset with respect to one another.

20. The optical switch of claim 19 wherein each of said wavelength selective elements arranged in the first array direct the selected wavelength component to another of said wavelength selective elements arranged in the second array.

21. The optical switch of claim 7 wherein the plurality of wavelength selective elements are arranged in a closed configuration.

22. The optical switch of claim 21 wherein said closed configuration is a circular configuration.

23. The optical switch of claim 21 wherein said free space region defines a polygon.

24. The optical switch of claim 16 further comprising a focusing mirror arranged in the first array, said focusing mirror reducing insertion loss by adjusting a beam waist location of the optical signal.

25. The optical switch of claim 23 wherein the free space region is ambient air.

26. The optical switch of claim 23 wherein the free space region is silica glass.

27. The optical switch of claim 5 further comprising a collimating lens disposed between each one of said wavelength selective elements and the optical element associated therewith, each of said optical elements being positioned at a focal point of the lens associated therewith.

28. The optical switch of claim 27 wherein said collimating lens and said optical element serve as a retroreflector.

29. The optical switch of claim 1 wherein said optical arrangement includes at least one collimating lens and at least one tiltable mirror.

30. The optical switch of claim 5 wherein said optical elements each include a collimating lens and a tiltable mirror.

31. The optical switch of claim 1 wherein said optical signal includes first and second pluralities of wavelength components and said optical arrangement includes first and second optical arrangement subassemblies, each of said optical arrangement subassemblies comprising:

at least one wavelength selective element selecting one of said wavelength components from among the first or second pluralities of wavelength components; and

a plurality of optical elements each associated with one of the wavelength selective elements, each of said optical elements directing the selected

wavelength component selected by the associated selective element to a given one of the plurality of input/output ports independently of every other wavelength component, said given input/output port being variably selectable from among any of the plurality of input/output ports.

32. The optical switch of claim 31 further comprising an optical coupling arrangement directing the first plurality of wavelength components to the first optical arrangement subassembly and directing the second plurality of wavelength components to the second optical arrangement subassembly.

33. The optical switch of claim 32 wherein said optical coupling arrangement includes a filter reflecting the second plurality of wavelength components to the second optical arrangement subassembly and transmitting therethrough the first plurality of wavelength components.

34. The optical switch of claim 33 wherein said optical coupling arrangement further includes a prism receiving the first plurality of wavelength components from said filter and directing the first plurality of wavelength components to the first optical arrangement subassembly.

35. The optical switch of claim 7 further comprising a focusing mirror arranged in an optical path traversed by the optical signal between a pair of the wavelength selective elements, said focusing mirror reducing insertion loss by adjusting a beam waist location of the optical signal.

36. A method for directing a first wavelength component of an optical signal that includes at least one wavelength component from a first input/output port to any selected one of a plurality of input/output ports that includes said first input/output port, said method comprising the steps of:

receiving the optical signal at the first input/output port;

selecting the first wavelength component if the optical signal includes a plurality of wavelength components;

selecting a given input/output port from among any of the plurality of input/output ports; and

directing the first wavelength component to the given input/output port.

37. The method of claim 36 wherein the first input/output port and the given input/output port are the same port.

38. The method of claim 36 wherein the step of directing the first wavelength component includes the step of directing the first wavelength component through a free space region.

39. The method of claim 36 wherein the step of selecting the first wavelength component includes the step of demultiplexing the first wavelength component with a thin film filter having a passband corresponding to the first wavelength.

40. The method of claim 38 wherein the first wavelength component is directed through the free space region by a tiltable mirror.

41. The method of claim 40 wherein the tiltable mirror is a MEM mirror.

42. The method of claim 41 wherein said MEM mirror is a retroreflective MEM mirror assembly.

43. The method of claim 36 wherein said optical signal is a broadband optical signal.

44. A method for directing at least first and second wavelength components of a WDM signal that includes a plurality of wavelength components from a first input/output port to any selected one of a plurality of input/output ports that includes said first input/output port, said method comprising the steps of:

receiving the WDM signal at the first input/output port;

selecting the first wavelength component from among the plurality of wavelength components;

selecting a given input/output port from among any of the plurality of input/output ports;

directing the first wavelength component to the given input/output port; and

directing the second wavelength component to another given one of the plurality of input/output ports selected independently from the given input/output port to which the first wavelength component is directed.

45. The method of claim 44 wherein the first input/output port and the given input/output port are the same port.

46. The method of claim 44 wherein the steps of directing the first and second wavelength components include the steps of directing the first and second wavelength components through a free space region.

47. The method of claim 44 wherein the step of selecting the first wavelength component includes the step of demultiplexing the first wavelength component with a thin film filter having a passband corresponding to the first wavelength.

48. The method of claim 46 wherein the first wavelength component is directed through the free space region by a tiltable mirror.

49. The method of claim 48 wherein the tiltable mirror is a MEM mirror.

50. The method of claim 49 wherein said MEM mirror is part of a retroreflector optical assembly.

51. The method of claim 48 wherein said tiltable mirror includes a piezoelectric actuator.

52. The method of claim 48 further comprising the step of collimating the first wavelength component before it is incident upon the tiltable mirror.

53. The method of claim 47 wherein the demultiplexing and directing steps are performed by a plurality of narrow band free space switches.

54. The method of claim 53 wherein said free space switches include a retroreflective mirror.

55. A method for directing at least first and second wavelength components of a WDM signal that includes a plurality of wavelength components from a first input/output port to any selected ones of a plurality of input/output ports that includes said first input/output port, said method comprising the steps of:

(a) demultiplexing the first wavelength component from the WDM signal;

(b) directing the first wavelength component to a given input/output port; and

(c) demultiplexing the second wavelength component from the WDM signal and directing the second wavelength component to one of the plurality of input/output ports selected independently from the given input/output port.

56. The method of claim 55 wherein step (c) is performed subsequent to steps (a) and (b).

57. The method of claim 55 wherein the steps of directing the first and second wavelength components include the steps of directing the first and second wavelength components through a free space region.

58. The method of claim 55 wherein the first wavelength is demultiplexed by a thin film filter having a passband corresponding to the first wavelength.

59. The method of claim 57 wherein the first wavelength component is directed through the free space region by a tiltable mirror.

60. The method of claim 59 wherein the tiltable mirror is a reflective mirror.

61. The method of claim 60 wherein said reflective tiltable mirror includes a piezoelectric actuator.

62. The method of claim 59 further comprising the step of collimating the first wavelength component onto the tiltable mirror.

63. The method of claim 55 wherein the demultiplexing and directing steps are performed by a plurality of narrow band free space switches.

64. The optical switch of claim 5 further comprising a detector associated with each of the wavelength selective elements for monitoring the wavelength component transmitted therethrough.

65. The method of claim 55 further comprising the step of monitoring the first wavelength component after performing the demultiplexing step.

66. An optical switch comprising:

a plurality of input/output ports for receiving one or more wavelength components of a WDM signal that includes a plurality of wavelength components; and

means for selecting one of said wavelength components from among the plurality of wavelength components and directing the selected wavelength component selected by the associated selective element to a given one of the plurality of input/output ports independently of every other wavelength component, said given input/output port being variably selectable from among any of the plurality of input/output ports.

67. The optical switch of claim 66 wherein said selecting and directing means comprises a plurality of narrow band free space switches.

68. The optical switch of claim 66 wherein said selecting and directing means comprises a wavelength selective element and an optical element associated therewith.

69. The optical switch of claim 68 wherein said wavelength selective element is a thin film filter.

70. The optical switch of claim 67 wherein said narrow band free space switch includes a thin film filter and a tiltable optical element.

71. The optical switch of claim 70 wherein said tiltable optical element is a tiltable mirror.

72. The optical switch of claim 68 wherein said wavelength selective element is a bulk diffraction grating.

73. The optical switch of claim 55 further comprising a detector associated with each of the narrow band free space switches.

74. The optical switch of claim 66 further comprising a free space region disposed between the input/output ports and the selecting and directing means.

75. The optical switch of claim 74 wherein said free space region comprises an optically transparent substrate having first and second parallel surfaces, said selecting and directing means including a plurality of wavelength selective elements arranged in first and second arrays extending along the first and second parallel surfaces, respectively.

76. The optical switch of claim 74 wherein the free space region comprises air as a medium in which the optical signal propagates.

77. The optical switch of claim 74 wherein the optically transparent substrate is silica glass.

78. The optical switch of claim 75 wherein said first and second arrays are laterally offset with respect to one another.

79. The optical switch of claim 78 wherein each of said wavelength selective elements arranged in the first array direct the selected wavelength component to another of said wavelength selective elements arranged in the second array.

80. The optical switch of claim 68 wherein said optical element is a retroreflector.

81. The optical switch of claim 70 wherein said tiltable optical element includes a tiltable mirror and a collimating lens.

82. The optical switch of claim 29 further comprising a correcting optical element disposed between the collimating lens and said tiltable mirror for reducing insertion loss.

83. The optical switch of claim 82 wherein said optical element is a tiltable mirror and said correcting optical element is a convex-concave lens.

84. The optical switch of claim 83 wherein at least one surface of said convex-concave lens has a spherical radius of curvature substantially equal to a distance between a surface of the lens and the tiltable mirror.

85. The optical switch of claim 81 further comprising a correcting optical element disposed between the collimating lens and said tiltable mirror for reducing insertion loss.

86. The optical switch of claim 85 wherein said correcting optical element is a convex-concave lens.

87. The optical switch of claim 86 wherein said convex-concave lens has a spherical radius of curvature substantially equal to a distance between at least one surface of the lens and the tiltable mirror.